PROGRESS REPORTS

FROM

EXPERIMENT STATIONS

SEASON 1957-58

NYASALAND

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The Cotton Pest Research Scheme is a Colonial Development and Welfare Scheme in conjunction with the Nyasaland Agricultural Production and Marketing Board and the Federal Government; its team of entomologists are stationed at its headquarters at the Gatooma Research Station, Southern Rhodesia, and at Makanga.

NYASALAND

PROGRESS REPORT FOR THE SEASON 1957-58

BY

J. M. MUNRO.

COTTON SEASON.

Province	*Type of crop*	*Legal sowing dates*	*Harvest*	*Legal uprooting date*
Southern, Central	Summer	15 Nov.-7 Jan.	Apr.-July	31 July
Northern	Winter	16 Apr.-15 June	Oct.-Jan.	15 Jan.

Rainfall.	*Nov.-April.*	*May-Oct.*	*Total*
Makanga	20·63	2·66	23·29
Chitala	30·50	nil	30·50

INTRODUCTION.

Makanga Station.

Weather.—The dry season was marked by an unusual absence of cloudy weather, and a very hot, dry November; temperatures of over 100°F. were registered on 24 days during that month.

Good planting rains fell on 14th-15th December, and the majority of the crops were planted in the following week. The growing season was short, with an abrupt cessation of effective rain at the end of February, about a month earlier than usual. Harvesting conditions were good, though cloud and drizzle interfered with the last picking of cotton.

Staff.—The farm manager, Mr. D. F. Collings, went on vacation leave on 30th June. Mr. A. Tullach took over from 15th September 1958.

Equipment and buildings.—A farm produce store was completed in June 1958. A second tractor and additional tractor equipment were purchased during the year. Laboratory and small-scale ginning facilities have been improved by the provision of a small electric generator near the office.

Cotton Pest Research Scheme.—Mr. G. A. Matthews has been appointed to Gatooma to fill the vacancy for a third entomologist. Plans for a continuation of the scheme for a further period of three years from January 1960 have been submitted.

The Cotton Season.

Northern Province.—The winter-grown crop around Karonga showed a considerable improvement this season. Planting conditions were good, though somewhat delayed on flood land; dry weather in December and January gave good conditions for picking. The same

conditions, however, were not satisfactory for planting the wet season rice crop.

Red bollworm was found in the Lufira valley in October, and spread southwards through the whole of Karonga by the end of the season. An outbreak on this scale has not been reported since winter cropping was established in 1938. It developed too late to have a serious effect on the crop, but illustrates the narrow margin by which control has been achieved. The uprooting date last season was postponed from 15th to 31st January 1958, and action against a few offenders was delayed for administrative reasons; it is suspected that this may have been the cause of the outbreak in October.

Central Areas.—Cotton acreage was less than last year, as a result of a succession of poor crops. Planting was earlier than in the south, but the rains finished at the end of February. Red bollworm again caused severe damage in the Salima and Kota Kota areas, but stainer damage was slight; the lake shore area of Dedza district was very free from pests, and yields were the best seen for some years.

In the upper Shire valley, a severe attack by American bollworm was experienced at Toleza and in parts of Lisungwe. There was also considerable loss from red bollworm throughout the area.

Lower River.—The growing season was short, but an increase in the cotton acreage and the absence of stainers until late in the season resulted in a much larger crop of cleaner cotton than last year. Much of the cotton was planted dry, and germinated well about mid December. Jassid was more plentiful than usual from Ngabu southwards, and a considerable amount of angular leaf spot and blackarm developed in February.

Red, American and spiny bollworm were present throughout the Lower River, but only in the extreme south at Tengani was there serious loss of crop from these pests.

In spite of the absence of stainers, 18% of the crop bought was Grade 2. In a few areas less cotton was left in the fields than usual, but on the whole it was much the same as last year. It had been assumed in the past that roughly 10% Grade 2 can be expected in the absence of stainers (as in 1947, 1951 and 1952), owing to bollworm, trash and other causes, and that anything above this figure is the result of stainer damage. It now appears that bollworm damage can result in a higher proportion of Grade 2 cotton than was thought.

Little uprooting was done before the middle of July, although picking was, or could have been, completed at least a month earlier. The average yield is estimated at 361 lb. per acre of seed cotton.

Cotton production.—The following figures published by the Agricultural Production and Marketing Board show the African Trust Land production in the three provinces for the last two seasons.

SEED COTTON PURCHASED IN SHORT TONS.

Province	*1957 crop*		*1958 crop*	
	1st Grade	*2nd Grade*	*1st Grade*	*2nd Grade*
Northern	243	12	379	21
Central	137	46	127	29
Southern	2,907	943	4,035	922
Total	3,287	1,001	4,541	972

COTTON BREEDING.

Albar 51.

Albar 637 is now being multiplied to replace CLB as the commercial cotton of Nyasaland. 200 acres were grown at the Agricultural Production and Marketing Board farm at Toleza; the yield was only 400 lb. per acre of seed cotton, mainly as a result of an attack of American bollworm which developed in spite of regular spraying with endrin. In the Kholombidzo market area, where 8 tons of seed were planted in African gardens, American and other bollworms caused so much damage that only one ton of seed cotton was brought to market, in spite of the use of insecticidal dusts. The two areas are only some 25 miles apart in the upper Shire valley, and coincided with the area where American bollworm attack was most severe; it is possible that the insecticides applied aggravated the attack by killing the normal predators.

In 1958-59, 200 acres will be planted at Toleza, and about 800 acres in the Chapananga market area in the Lower River.

TABLE 1.

COTTON VARIETY TRIALS.

Lint yields in lb. per acre.

Variety	*Makanga*	*Ngabu*	*Chitala*	*Lower River*
CLB	84	150	228	272
CL20	112	190	234	—
A637	124	301	296	328
A629	114	201	294	273
A640	143	284	310	280
A474	125	251	233	—
ABC30	117	226	248	272
ABC31	131	—	309	—
ABC40	126	247	272	—
ABC109	125	—	286	—
ABC120	140	268	253	—
ABC122	113	—	271	—
ABC146	145	311	281	—
AC31	139	244	345	—
Sign. diff. (P=·05)	27	72	44	Not sign.
S.E.	± 9·7	±25·5	±15·8	±22·6
Co-eff. of var.	20%	22%	15%	40%
Replications	6	6	6	25
Planted	3.12.57	9.12.57	17.12.57	Various

Plot size 1/145 acre. Spacing 3 ft. × 2 ft., 3 plants per hole. Station trials were 5 × 5 balanced lattices; Lower River district plots consisted of a single replication in each garden.

The trials on Makanga and in the Lower River (Table 1) showed a much higher co-efficient of variation than last year; American bollworm and the shedding of apparently undamaged bolls resulted in very poor yields at Makanga, and probably contributed to the high standard error.

In spite of this, the Albars again showed a convincing improvement in yield over CLB in the variety trials. A637 yielded over 70 lb. more lint per acre than CLB, an increase of 40%.

TABLE 2.

SPINNING TESTS.

	Effective length	*Maturity ratio*	*Standard fibre weight*	*Count strength product*	*Fibre strength g/tex*
Makanga (1956-57—Trial 7/4)					
CLB	38	·93	178	2226	20·6
CL20	38	·885	165	2277	20·8
A637	38	·92	176	2270	21·4
ABC30	38	·865	185	2220	20·6
31	40	·85	189	2081	21·2
40	38	·85	188	2189	20·4
51	38	·885	174	2326	20·6
109	39	·94	176	2254	21·7
120	39	·86	171	2375	21·5
122	38	·82	177	2248	21·8
146	40	·805	191	2232	20·9
AC31	39	·865	181	2262	21·3
Karonga (1957-58)					
CLB	38	·98	187	2087	20·9
A637	39	1·00	197	2034	19·5
CLB (1)	39	1·035	172	2239	21·2
CLB (2)	38	1·035	184	2000	19·3
CLB (3)	36	·97	184	1833	19·4

Table 2 shows that there was little or no difference in spinning quality between CLB and A637 in this year's tests; in all previous tests, A637 has been consistently better.

Single plant selections.—The single plant selections made in 1957 from A637 and the related Albars were graded for resistance to jassid and bacterial blight, the latter after needle inoculation with cultured bacteria. Some 80 selections have been retained for further observation and testing.

Three recent Albar selections from Namulonge—Albar A(56)16, 22 and 23—were grown. All these have given high ginning outturns in Uganda, but jassid resistance was found to be only moderate. A few selections which appeared above average for jassid resistance were made.

Albar crosses.—The Albar 49 crosses (ABC and AC in Tables 1 and 2) were tested in the full scale variety trials. As in 1957, they showed improvement over CLB, and one or two appear to be in the same class as A637.

The F_1 of the Albar 51 crosses made last year was grown. UPA(56)5 from Uganda showed rather better jassid resistance than the Albar A(56) selections; this cross, Albar 51 × (MU8 × BP52 × BP52), is among those made here last year.

Ginning percentage.—Weekly pickings were taken in Trial 8/15; these were ginned separately in order to get more information on the change in ginning percentage through the season reported last year from the records of Chiromo ginnery.

There was a very steep rise in ginning percentage from 6th May to the final picking on 10th June (Fig. 1), accompanied by a fall in seed weight. A rise in the lint index from 4·7 to 5·2 means that the lower seed weight does not fully account for the increased ginning percentage, except perhaps in the last picking.

Storage of seed cotton has had no appreciable effect on the ginning percentage (Fig. 2).

North Nyasa Cotton.

Any increase in cotton acreage in the Karonga district must be found in the "dry land" areas—those which are near the rivers, but not normally flooded in the wet season. It is these areas which have gone out of production since 1953, when a peak of 590 tons of seed cotton was reached in the Northern Province. Three samples of seed cotton were chosen by the Agricultural Officer of the district to represent different growing conditions.

CLB (1). Best "Dimba" (flood land) cotton.
CLB (2). Best dry land cotton.
CLB (3). Medium dry land cotton.

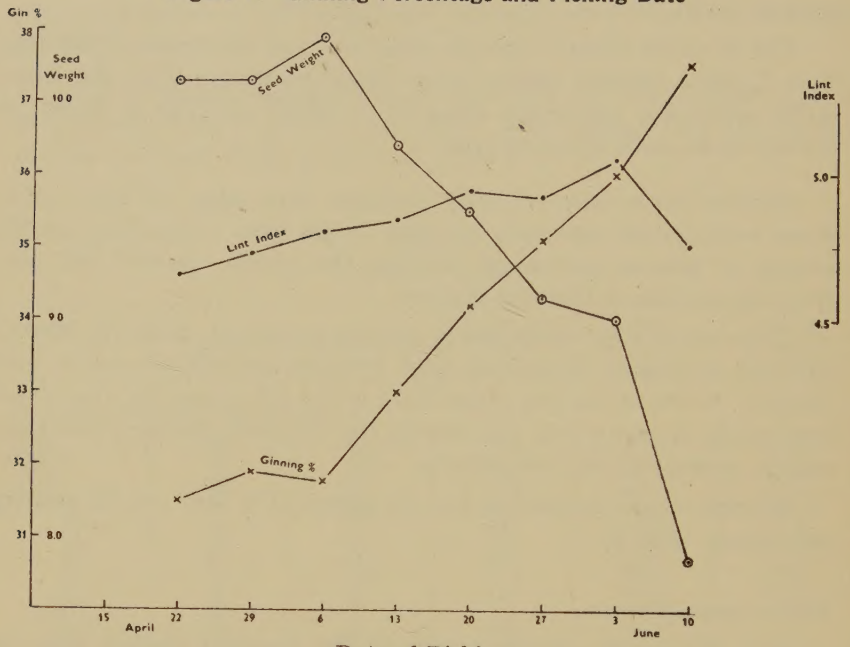
These were ginned at Makanga, and sent for spinning tests (Table 2). The more difficult growing conditions have resulted in a marked reduction in staple length and yarn strength.

Husbandry and Rotation Crops.

Manuring and Fertilisers.

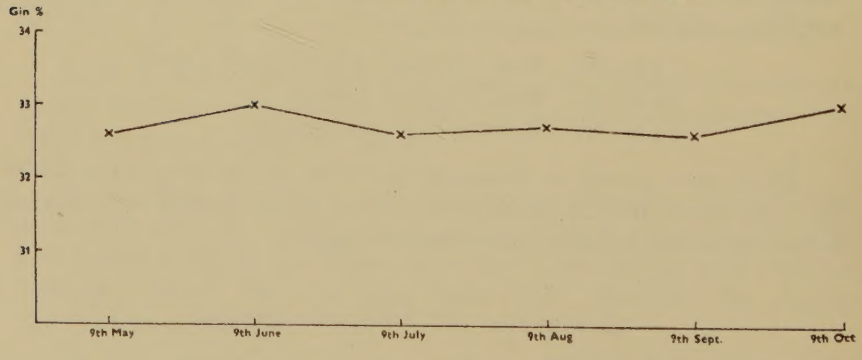
Dry season and wet season crops were taken on the three irrigation fields A, B and C, where long-term manurial trials were started in 1957; regular applications of fertiliser are applied to certain crops in the rotation.

Figure 1. Ginning Percentage and Picking Date



Date of Picking

Figure 2. Effect of Storage on Ginning Percentage



Date of Ginning

No increases in yield from nitrogen, phosphate or cattle manure were recorded, but nitrogen depressed the yield of linseed and cotton. The crops were:—

	Irrig. A.		*Irrig. B.*		*Irrig. C.*	
Dry season 1957 ...	Linseed	N	Wheat	N	Beans	
Wet season 1958 ...	Soya beans	P	Cotton	N P	Maize	D

Treatments: N = 0, 100, 200 lb./acre sulphate of ammonia.
P = 0, 100, 200 lb./acre superphosphate.
D = 0, 10, 20 tons/acre cattle manure.

What appears to be the first positive response to nitrogen at Makanga occurred in a small trial in the 1957 dry season (Table 3), although, as there were only two replications, the variance ratio did not quite reach the 5% level. This trial was put down following a suggestion that the high temperatures experienced in the wet season limited the yield of maize. The response to sulphate of ammonia is considerable, but the high yield per acre is due to some extent to edge effects at the ends of the small plots: guard rows were planted only at the sides.

TABLE 3.

MAIZE MANURIAL TRIAL.

Makanga—Field J—Trial 7/26.

Yields of shelled maize in lb. per acre.

Control	2860
250 lb. per acre sulphate of ammonia	3286
500 lb. per acre sulphate of ammonia	4031
Standard error	± 150·4
Co-eff. of variation	6%

Randomised blocks. 2 replications of 3 treatments, in plots of 1/161 acre. Spacing 3 ft. × 3 ft., 3 plants per hole. Manured 5.7.57 and 31.7.57 (2/5 and 3/5). Irrigation factor 0·8.

A positive response to nitrogen was also found in maize in the 1957-58 season—trial 8/5. This trial was planted on land recently ploughed up after 5 years of elephant grass.

Mulching.

Straw mulching is the only treatment which has given reasonably consistent increases in yields at Makanga. This year, trial 8/5 showed an increase of 400 lb. per acre of maize (15%), and trial 4/2 showed an increase of 116 lb. per acre of seed cotton (14%). There was no difference in yield between flat and ridge cultivation in this trial.

(Trials 4/2 and 8/5 are fully reported in the Annual Report of the Department of Agriculture, Part 1).

Rotation.

Two rotation trials have been laid down this year in field 9 to obtain some basic information on the effects of crop rotation on these soils. In trial 8/11, continuous cropping with cotton and maize is compared with a two-year rotation of these crops, and a three-year rotation including groundnuts. Trial 8/10 has the same three-year rotation, and includes manuring and fallow treatments. All phases of the rotations occur every year in both trials.

Irrigation.

The Irrigation Project.

Introduction.—The Shire Valley Project, which would lead to control of the Shire river, has been mentioned in previous reports. In anticipation, plans for a pilot irrigation scheme at Makanga were drawn up in 1953, and construction work was completed in December 1954. The first irrigated crops were planted in the 1955 dry season. The severe flood in April 1956 destroyed the 1955-56 crops, damaged the irrigation channels and silted up the pump and river intake; no dry season cropping was possible.

An improved water supply was installed during 1956-57, and the original plan was extended to include about ten acres of newly acquired land above the 1952 flood level.

The objects of the scheme are: —

(1) to obtain information on the yields to be expected from as wide a range of crops as possible;

(2) to ascertain the water requirements of the main crops being grown;

(3) to investigate different methods of applying irrigation water to the land.

Irrigation methods.—Basin irrigation has been adopted as the standard method for experimental work, as it appears to be the best adapted to the measurement of water applied. The basins measure 10 yds. × 15 yds. (1/32 acre); the standard watering is 2 inches per application, applied at a rate of 0·5 to 1·2 cusecs.; water measurement is by 90-degree triangular weir or by free-flowing rectangular orifice—the latter is more restricted in range, but gives a more accurate measurement at the rates of flow required.

Furrow irrigation by siphon tubes was used originally, but it is difficult to measure water accurately on to small plots by this method.

Rotations.—Nine fields, each of just over one acre, are divided into two groups of three and six respectively, to give the following rotations:—

Group 1 (3 years)		Group 2 (6 years)	
Wet season	*Dry season*	*Wet season*	*Dry season*
Cotton		Cotton	
Maize	Beans	Maize	Beans
Soya	Linseed	Soya	Linseed
	Wheat	Cotton	Wheat
		Lucerne	Lucerne
		Lucerne	Lucerne
			Lucerne

These rotations will be modified in the light of experience; already an alternative to linseed is being sought. The most troublesome crop to fit in is cotton, which may be on the ground until 31st July—a very late start for the following dry season crop.

Sugar cane, citrus and cocoa are being grown on a field scale, in addition to the annual crops in the rotations.

Manuring.—The intensive cropping in Group 1 (Fields A, B and C) may lead to depletion in soil fertility. A check on this is provided by long-term manurial trials laid out on each field, where nitrogen, phosphate, potash and cattle manure are applied to specific crops in the rotation; Group 2 receives no manure. These trials are described elsewhere in this report.

Crops and Yields.

The first objective is to find the most suitable crops to grow under irrigation; Table 4 summarises the results of the past year. In order to meet the capital cost of an irrigation project, not only good yields but high value per acre are important, and an attempt has been made to assess the comparative value of each crop. This is beset with difficulties; little is known as yet of costs of production, and gross value only is given; prices are as near as possible those obtainable in the Federation, but fluctuations make these difficult to determine; prices for perishable products depend on an adequate market and/or facilities for preservation such as a canning factory; and price fluctuations of primary products cannot be foreseen. With all these reservations, the values quoted give a fair idea of which crops are most likely to be profitable.

TABLE 4.

COMPARATIVE VALUE OF IRRIGATED CROPS.

Crop	*Acres*	*Yield/acre*	*Value*	*Value/acre*
Dry Season 1957.				
Linseed	·65	486 lb.	1/- per lb.	£24
Wheat	·87	1044 lb.	£30 per ton	£16
Maize	·18	2550 lb.	1d. per lb.	£10
Red beans	·93	Failed	£30 per ton	—
Beetroot	·04	10·5 tons	£8 per ton	£84
Carrots	·18	8·7 tons	£8 per ton	£70
Onions	·15	12·1 tons	3d. per lb.	£300
Potatoes	·07	5·6 tons	3d. per lb.	£140
Lucerne meal	·91	3 tons	£20 per ton	£60
Sugar	·60	5 tons (estimated)	£50 per ton	£250
Wet Season 1957-58.				
Cotton	1·00	1100 lb. 275 lb.	6d. per lb. 2d. per lb.	£30
Maize	1·00	2470 lb.	1d. per lb.	£10
Soya beans	1·00	1220 lb.	£30 per ton	£18
Lucerne meal	·91	4 tons	£20 per ton	£80
Hibiscus fibre	·10	1800 lb.	£40 per ton	£36
Sunn hemp fibre	·10	Failed	£40 per ton	—

Dry Season Crops, 1957.

Wheat.—The Federal Government is anxious to increase the domestic production of wheat, as it is one of the largest imports. Four varieties were tested in a yield trial. Sabonera is the variety grown locally in the Kirk Range at around 5,000 feet above sea level; at Makanga, growth was rank, the crop lodged badly and the yield was low. There was no significant difference between the yields of the other three varieties, obtained from the Sabi Valley in Southern Rhodesia (Table 5).

TABLE 5.

WHEAT VARIETY TRIAL.

Makanga—Irrigation N—Trial 7/22.	
Variety.	*Yield of grain in lb. per acre.*
Sabonera	220
Kenya Governor (?)	1080
Kenya 261 R7C	986
Angola XZ–50	1002
Sign. diff. (P = ·05)	309
S.E.	± 102·8
Co-eff. of var.	31%

Plot size 1/258 acre. 6 replications of 4 varieties. Seed rate 100 lb. per acre, drills 7½". Planted 3.5.57.

Three dates of planting, ranging from 15th April to 17th May, all gave very similar yields. The variety planted was the one described as Kenya Governor (?) in Table 5; it resembles this variety, but contains a mixture of types.

Linseed. The crop appeared to grow well in spite of a rather poor initial stand, but the final yield was too low to be economic.

Red beans.—Canadian Wonder beans were severely attacked by a stem-boring fly (*Agromyza phaseoli* Coq.) at the end of August; practically every plant died within a few weeks, and no crop was reaped.

Vegetables.—Vegetable crops do well in the dry season, and have a high value per acre even when high labour requirements are taken into account. The types grown were chosen for ease of handling and sufficient keeping quality to allow for transport by train to Limbe and Blantyre; most other European vegetables have been grown successfully here as garden crops in the dry season.

Onions are the most satisfactory in that they can be stored for upwards of three months. The large white varieties (Texas Grano and Early Cape Flat) are, however, not suitable for canning; one of the small red varieties will be tried next year.

Wet Season Crops, 1957-58.

Cotton.—Cotton has so far been grown only during the wet season, because of the danger of building up red bollworm if it is grown throughout the year. Under large scale irrigation, it would be possible to grow cotton as a dry season crop; this is done in northern Nyasaland, and the crop is very free from pests, but it must be emphasised that both systems cannot be permitted in the same area.

Early planting of cotton is at present limited by the onset of the rains, but with irrigation it is possible to plant at any time. Trial 8/16 was designed to measure the effect on yield of very early planting; cotton was planted in mid October, mid November and mid December, the last planting coinciding with the first planting rains. The results were unexpected. The early planted cotton, even that receiving no irrigation after 15th December, grew 10 feet tall; little or no crop was set until February—and then at the top of the plant. The plants were top-heavy, and blown into a tangled mass by wind and rain, so that it was practically impossible to get into the crop to pick it until the plants were uprooted at the end of the season. The November planted cotton gave the best yield, but at only 1,250 lb. per acre it was not significantly better than the other treatments (Fig. 7, p. 18).

Maize.—Planting before the start of the rains gave a small increase in yield, mainly because the December planting was heavily infected by rust (*Puccinia polysora*). Unreplicated plots of a resistant variety gave the same yield whether planted in October, November or December.

Closer spacing increased the number of cobs per plot, but this increase was nullified by a reduction in cob size.

Soya beans.—This crop gave an excellent yield in 1956-57 — over 2,000 lb. per acre. In 1957-58 the germination was very poor; despite

this the yield of 1,200 lb. per acre was quite satisfactory. In the dry season, grown alongside the crop of red beans, the soya was not attacked by the stem boring fly.

Fibres.—A small area was planted with kenaf (*Hibiscus cannabinus*) in December. 1,800 lb. per acre of retted fibre was obtained, which could probably be bettered by earlier planting. A similar plot of sunn hemp yielded only a small quantity of weak fibre.

Perennial Crops.

Lucerne.—Mowing was not always possible at the proper time owing to pressure of other work, and the yields shown (Fig. 8, p. 18) could be improved upon. In good weather, one or two days are sufficient for making hay; this is ground into meal in an ordinary hammer mill, and shows a high protein content (Table 6).

TABLE 6.
LUCERNE MEAL.

Moisture content	3·1 per cent.
Oil and fatty matter	2·4
Crude protein	18·5
Fibre	28·4
Soluble carbohydrate	37·2
Ash, including:	10·4
Phosphate (P_2O_5)	0·6
Calcium (Ca)	1·3
Potash (K)	2·7
Magnesium (Mg)	0·4
Starch equivalent	66
Nutritive ratio	1 : 2·4

Sugar.—Estimates for this crop are tentative, as they are derived from samples taken from a collection of 22 varieties, and no determination of sugar content has been made. The average yield of cane for all varieties was 53 tons per acre from the second cut, and sugar content has been taken as 10%.

Cocoa.—About half an acre of cocoa has been established under the shade of bananas. Seed was planted in December 1957 in baskets and at stake in the field; the latter gave rather poorer germination, but many of the basket plants were checked or died when they were planted out. Direct planting in the field has given the strongest plants.

Citrus.—Two varieties of oranges have been planted in Field M. These will receive uniform watering until they come into bearing; planting has been arranged so that different irrigation rates can be applied later. There has been a considerable attack by scale insects on some of the young trees.

Crop Water Requirements.

Experimental methods.—Published figures for crop water requirements vary so widely that they are of little practical value in a country

with little or no practical experience of irrigation. As a starting point, therefore, the irrigation experiments at Makanga have been based on the following assumptions: —

1. Evapotranspiration is related to the evaporation measured by the open pan evaporimeter.
2. Evapotranspiration in a growing crop is related to leaf area of that crop.

In this report, the term "irrigation factor" means the ratio of irrigation water used to the open pan evaporation for the same period, both measured in inches; and the "leaf area index" means the area of leaf lamina per unit area of land surface. Where not otherwise stated, an irrigation factor of 0·8 has been used.

Figure 3. Piche and Open Pan Evaporation

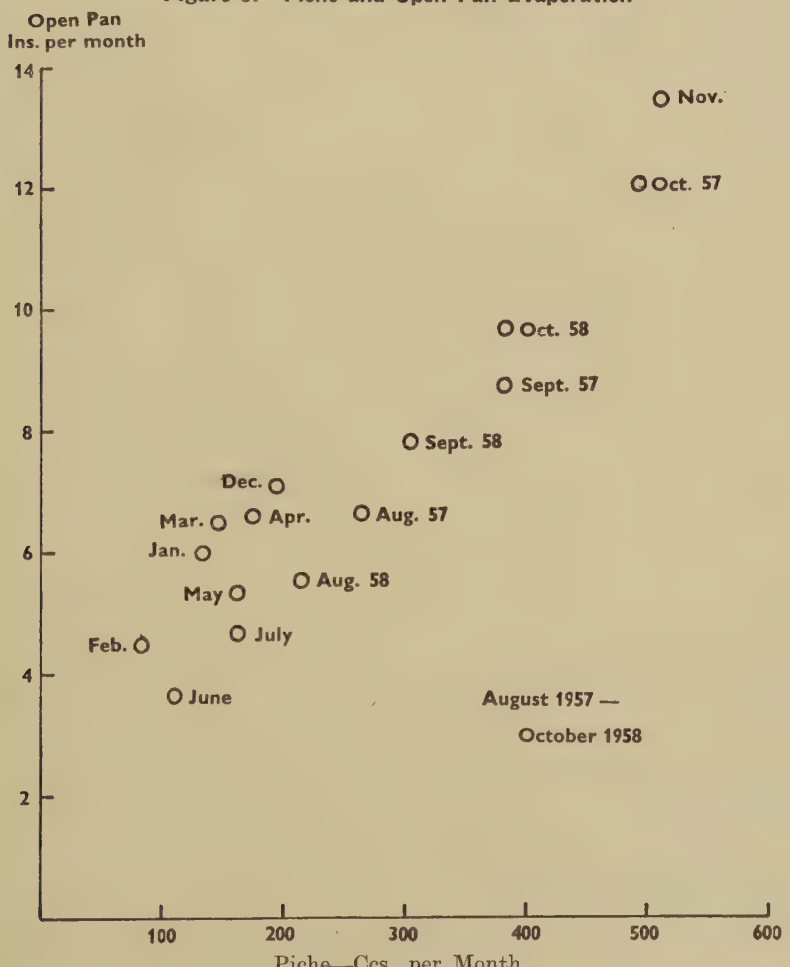


Figure 4. Leaf Area Index—Cotton

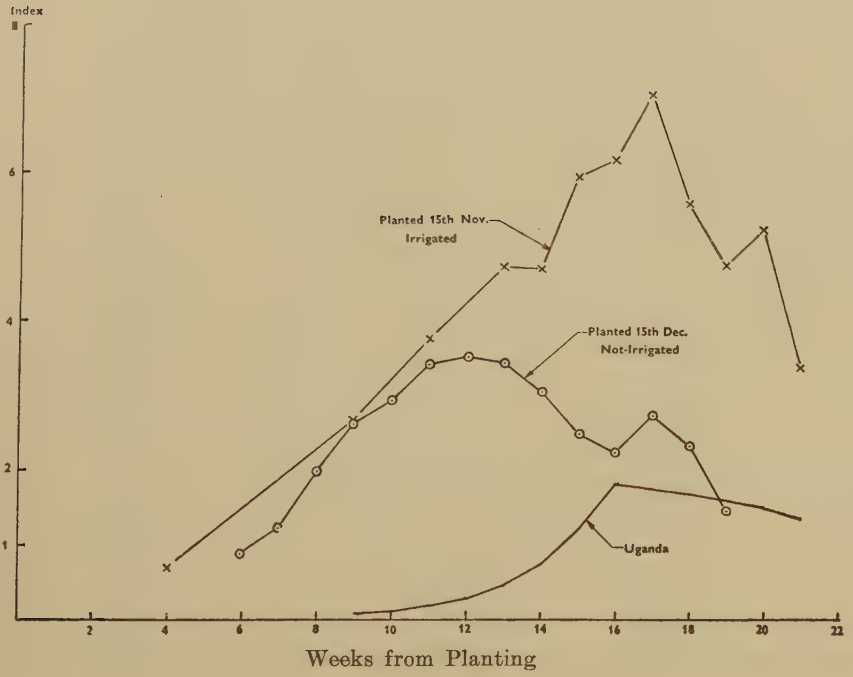
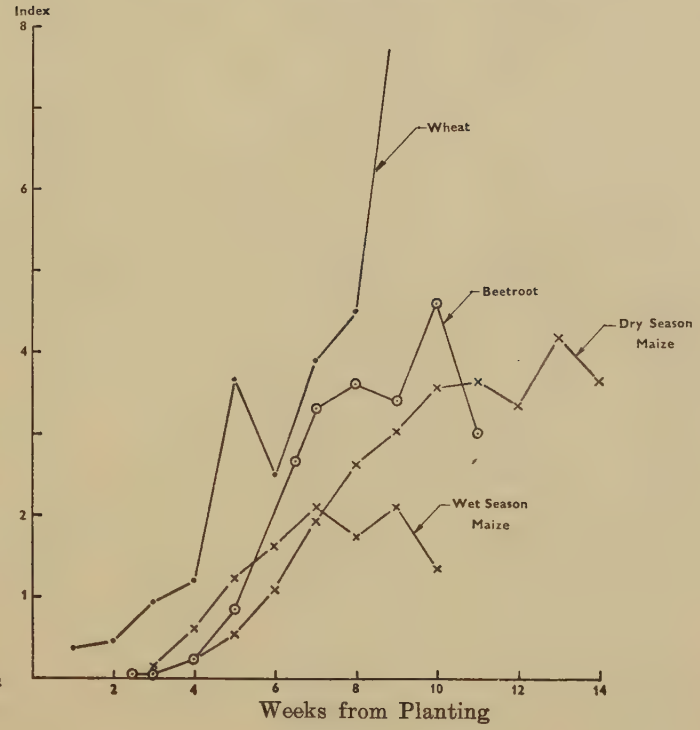


Figure 5. Leaf Area Index—Other Crops



Measurement of evaporation.—The Water Development Department installed one of their standard open pan evaporimeters at Makanga in 1953, and the readings from this are used in the calculation of irrigation requirements. The pan is 48″ in diameter and 16½″ deep, with a gauging hook 3″ from the top; it is mounted 5″ above ground level and protected by a wire grid.

Since August 1957, a pair of Piche evaporimeters have been recorded in the open near the pan. Monthly evaporation measured by the two methods is compared in Fig. 3; the open pan readings are rather higher in the wet season months December to April, but this is not entirely due to losses by rain splash—the April readings (6·58″, 171·0 ccs.) were made during dry weather (rainfall 0·18″).

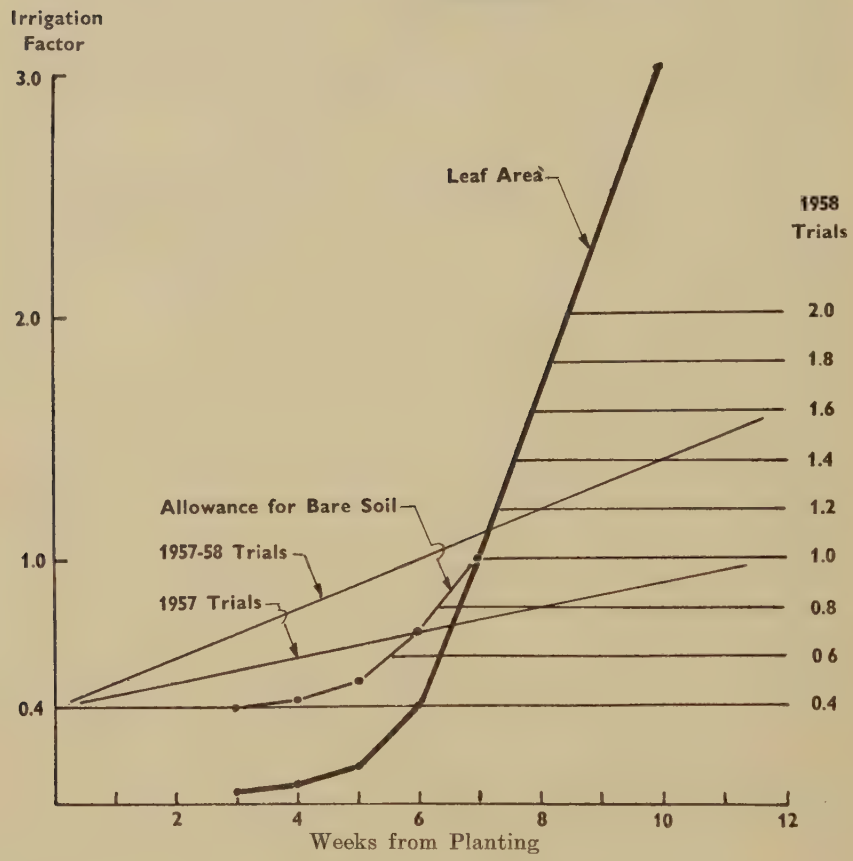
Leaf area measurements.—Discs of known size were punched from fresh leaves, and the discs and leaves weighed immediately. An allowance (based on dissected samples) of 13% by weight is made for the leaf veins in cotton; a similar allowance of 37% is made for the midribs in maize. This method allows a large number of samples to be handled quickly, and a high standard of accuracy is not essential for the present purpose.

Typical leaf area curves are shown in Figs. 4 and 5. The most striking feature is the difference between cotton leaf development here and in Uganda; the increase is much quicker, and a much higher leaf area index is reached, especially under irrigation. It is probable that the relation between leaf area index and evapotranspiration demonstrated at Namulonge breaks down above 1·6, when available energy becomes the limiting factor. Current field experiments are designed to see when this point is reached for various crops. The design of these experiments is illustrated diagrammatically in Fig. 6; all treatments are watered according to the leaf area index, making an allowance for evaporation from bare soil, until the particular treatment index (=irrigation factor) is reached; this factor is then applied for the rest of the period of the experiment.

As all the crops measured reach an index of 1·0 in 5 to 7 weeks, it may well be that this preliminary stage could be omitted, and the final factor applied from the start; there would be little waste of water, and the calculation of irrigation requirements would be very much simplified.

Fig. 6 also illustrates the actual irrigation factors used in the 1957 dry season and the 1957-58 experiments, which were started before leaf area measurements had been made. In 1957 the irrigation factor was increased by 0·1 every two weeks, starting at 0·3; this approximates to the cotton leaf area index curve in Uganda. This rate of increase appeared to be too slow, as some crops ripened in three months, and in the 1957-58 season the factor was increased by 0·1 every week.

Figure 6. Makanga Irrigation Experiments (Diagramatic)



Soil moisture.—Little work on soil moisture measurement has so far been attempted. A few gypsum blocks were installed under a maize crop in the 1957 season, but readings were made at rather irregular intervals. It was apparent, however, that irrigation of maize using a factor of 0·8 allowed soil moisture in the top four feet of soil to fall nearly to wilting point.

The Agricultural Chemist, Chitedze, has installed a series of gypsum blocks in each irrigation basin in field L, to measure the changes in soil moisture at 1 ft., 2 ft., and 4 ft. Regular readings are now being taken under a maize crop receiving different rates of irrigation; this field will be planted with the six different crops in the rotation during the next three years.

A drying oven for the direct determination of soil moisture will be in use next season.

Cotton.—The excessive vegetative growth of cotton when planted before the rains has already been referred to. This type of growth has been seen in raingrown cotton before now in seasons of early rains at Makanga, and presents a serious problem. The examination of shed bolls and buds this year showed that only about one-third of the shedding was due to visible insect damage. Irrigation was not excessive by standards applied elsewhere—about 60 inches are applied in a season in the Sudan, and up to 70 inches in California—and in trial 8/16 the rainfall plus irrigation ranged from 16 inches to 100 inches; yet the lowest water rates gave the best yields (Fig. 7). Climatic factors other than rainfall are being studied—a correlation has been shown elsewhere between cloudy weather and boll shedding—and a wide range of different treatments will be tested in observation plots in the 1958-59 season, to see their effect on growth and shedding.

Lucerne.—The most positive results obtained so far have come from trial 7/18, where different irrigation rates have been applied to lucerne. This trial was planted in June 1957; up to December the treatments were calculated at 0·8 of the open pan evaporation, and different "planned monthly deficits" were allowed to accumulate. The highest irrigation rate gave the highest yield at the first cutting, but subsequently there was little difference between treatments. The later cuts were taken at the hottest and driest time of year, with open pan evaporation over 12 inches per month, and it was realised that treatment differences of half an inch per month were relatively unimportant. From December onwards, a new set of treatments using factors ranging from 0·4 to 1·2 were introduced and it has been shown that the best yields are obtained with an irrigation factor of 1·0 to 1·2 (Fig. 8).

Wheat.—An interesting contrast is shown by wheat grown in the 1957 dry season. Here again the treatments differed in the planned monthly deficit, and the range was not very wide; but it was sufficient to show that the best yields are obtained with a mean factor of 0·4 to 0·6 (Fig. 9). This is all the more surprising as the leaf area index of wheat is the highest of any crop so far measured here, and the best yielding plots appeared to be short of water during the season as judged by colour and wilting.

Maize.—The range of irrigation rates was too narrow to give much information. Further trials are being carried out in both dry and wet seasons, to give a comparison between the same irrigation factor applied under widely different evaporation conditions.

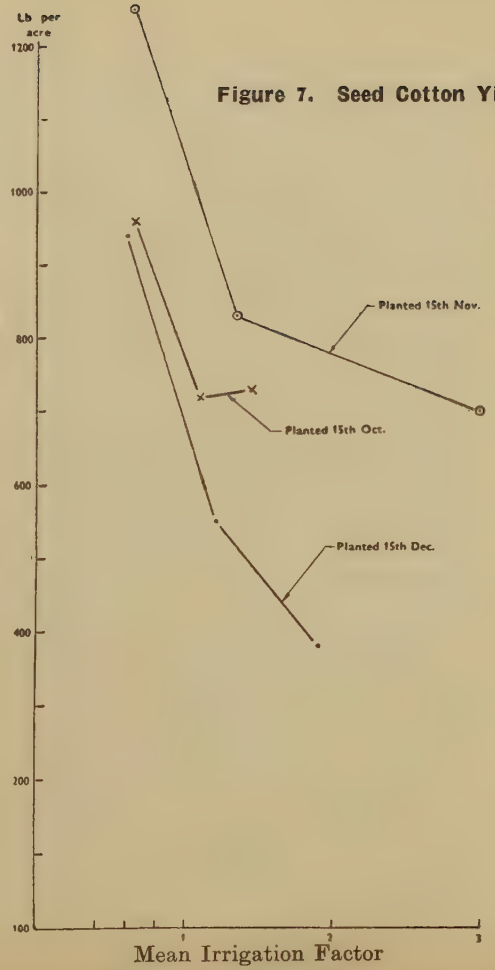


Figure 7. Seed Cotton Yields

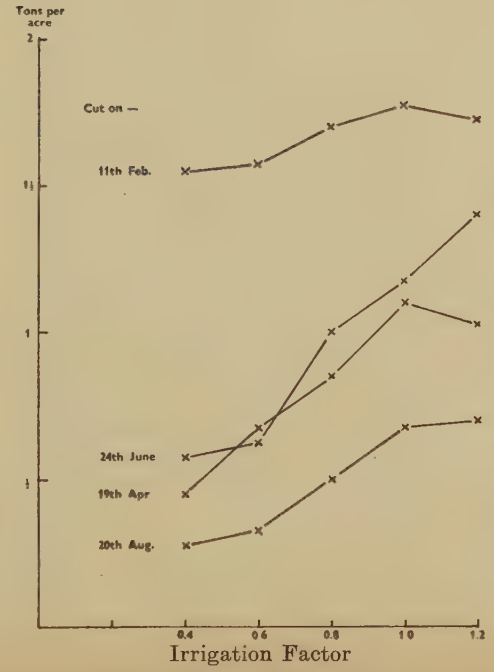


Figure 8. Lucerne Yields (air dry weight)

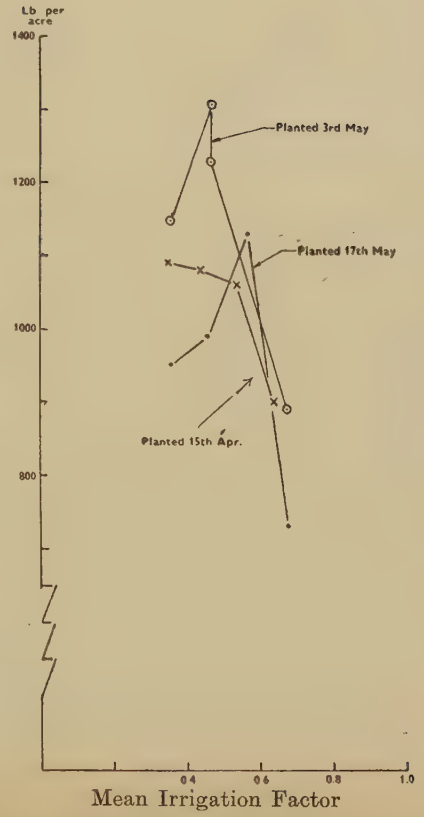


Figure 9. Wheat Yields

Pests.

BY

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(*Cotton Pest Research Scheme*)

Diparopsis castanea. (*Red bollworm*).—Generally speaking the population was lower than that of last season. The main carry-over moth flight occurred from January to March, and the peak period of egg-laying from April to May. During May a mean of approximately one egg per plant was found on Makanga farm.

The carry-over moth flight was smaller than last season, with a consequent smaller amount of initial shedding in general due to this insect. Shed examinations showed that between 50% and 70% of all sheds were due to red bollworm. This result is based largely on 10 plants on which all flowers were tagged to determine the fate of each fruiting point, but it is believed that elsewhere the average was lower. Weekly collections of shed green bolls were made on an extensive scale with numerous samples from 6 areas in the Lower River. In spite of considerable shedding in all these areas, sheds damaged by all species of bollworms amounted to only about one-third of all green bolls shed from February to April. Not until May and June did this figure increase to about half the total bolls shed.

Weekly green boll collections taken on fields on the station from the same sets of plants in each field gave the following figures for the whole period from February to mid June:

Field.	*Total number of green bolls shed. (10 plants)*	*Percentage of sheds due to all bollworms.*
1, plot 1	213	40%
1, plot 2	219	38%
N, plot 1	1087	28%
N, plot 2	886	32%
N, plot 3	855	37%

Field N was under irrigation. The percentage given in the last column includes all bolls damaged by any bollworm, and although the shedding has been attributed to bollworm this may not necessarily have been the case. Green boll shedding was greater on irrigated cotton than on raingrown cotton, but there was no increase in bollworm damage to account for it.

The causes of shedding of apparently undamaged bolls are not understood, but direct damage by other insects was not a contributory factor.

Soil sampling for red bollworm pupae after cotton uprooting in July gave a pupal population of 652 per acre in one sample area on

the station, 590 per acre in another, and 660 per acre in a series of samples taken in a number of native gardens. This is considerably higher than the 160 pupae per acre reported last season, but is still considerably lower than that reported from Southern Rhodesia.

The incidence of red bollworm in Central Province was higher than that in the Lower River, as in the 1956-57 season.

Dysdercus spp. (*Cotton stainer*).—Stainer damage was very slight this season, owing mainly to the late and uneven rains in the Lower River which greatly inhibited breeding on the alternate hosts. Thus the main invasion of cotton in February and March was very small and breeding on the cotton very slow. Not until early May did the numbers of stainers in the cotton fields become comparable with the population that occurred in late February—early March 1957. This was chiefly due to the favourable cloudy, drizzly weather during May and June and the high humidities prevailing, which encouraged rapid breeding on the cotton.

As last season, of the two major species, *D. intermedius* was the first to arrive in numbers on the cotton crop, and the first to begin to leave. *D. fasciatus* arrived late and was late to leave. *D. nigrofasciatus,* less important in general, was predominant in some fields in February and March. This was due to the low populations of the other species rather than to any considerable increase of *D. nigrofasciatus* population over that of last season.

Naturally, the low stainer population in general from February to April on the cotton resulted in a smaller amount of Grade 2 cotton. However, it was certain that by no means all the 18% Grade 2 was due to stainers. It was estimated on a basis of green boll samples and examination of seed cotton at the ginnery that only 3% to 4% of the Grade 2 cotton was downgraded on account of stainers this season. It was also obvious from these samples that bollworms were responsible for most of the remaining 14% or 15%. There seems little doubt that bollworms and other insects cause a fairly high proportion of Grade 2 cotton in any year.

Experiments showed that stainers did not cause any shedding of green bolls under caged conditions, and it seems unlikely that any shedding is ever caused under field conditions.

Although in the main cotton growing area of Chiromo-Sorgin-Ngabu the chief pre-cotton breeding host was *Sterculia africana,* as reported last season, this season's work has confirmed that the host-complex varies in different ecological areas. In some areas where *S. africana* is scarce the major pre-cotton breeding host may be *S. quinqueloba* or another. The sequence of hosts may vary considerably in different areas as well. The Lower River has been divided provisionally into

6 ecological areas, in each of which the bionomics of the stainer is being studied.

The known wild alternate breeding hosts of the stainer in Nyasaland are as follows:—

STERCULIACEAE—*Sterculia africana, S. appendiculata, S. quinqueloba.*
BOMBACACEAE—*Adansonia digitata, Bombax stolzii, Ceiba pentandra.*
MALVACEAE—*Hibiscus esculentus, H. cannabinus, H. vitifolius,* and possibly others; *Azanza garckeana* (*Thespesia garckeana*), *Abutilon guineense,* and possibly others.
MELIACEAE—*Trichilia emetica.*

A few other species are suspected but are not proven breeding hosts. As far as is known none of the *Hibiscus* spp., *A. garckeana, B. stolzii* or *T. emetica* is more than a very minor host in any Lower River area.

Generally, *D. intermedius* has a preference for *Sterculia* spp., while *D. fasciatus* is commoner on the Bombacaceae. *D. nigrofasciatus* has not been found to exhibit any distinct preferences.

Seed cotton in store is a post-cotton host of considerable importance.

Empoasca facialis and other jassids.—The jassid was one of the few pests apparently encouraged by the prevailing climatic conditions. Damage was noticeable, particularly in the Tengani and Sorgin areas, during the season. Damage early in the season was generally greater than that of last season, although most plants—even those seriously attacked—recovered to a considerable extent later in the year.

Earias biplaga. (*Spiny or Egyptian bollworm*).—This species caused some damage early in the season, when it was estimated in the Lower River that it caused about 10% of sheds due to bollworm. Later in the season it was less common on cotton, but occurred in some numbers on *Hibiscus* and other wild hosts. It was probably less common in general than last season.

In the central and lake shore areas it appeared to be quite numerous in some places—more particularly in the Lisungwe valley—and was probably a little commoner than in the Lower River.

Heliothis armigera. (*American bollworm*).—This species was considerably more common in both the Lower River and Central Province than last season. Locally it caused noticeable damage in the Lower River but nowhere reached serious pest proportions, although in a few areas it was found in some 15% to 20% of the total sheds.

In the upper Shire valley it did reach serious pest proportions in a few areas—notably in some fields near Matope and at Toleza. Comparatively little damage was done in the Lisungwe valley, however, or in the Dedza or lake shore areas.

Platyedra gossypiella. (*Pink bollworm*).—This pest was not recorded. Several larvae suspected of being of this species were bred, but proved to be those of other moths. Unfortuately, some of these failed to pupate. No pupae were found. If the species occurs in Nyasaland it is certainly very uncommon.

Argyroploce leucotreta.—This bollworm was occasionally locally common, notably in Mlolo area. It was found towards the end of the season only.

Calidea dregii.—This was considerably more numerous in some areas than during the previous season. In two gardens 4-5 per plant were recorded, the damage in these cases being serious. Generally, however, the species was not very common and populations of this high level were rare.

Zonocerus elegans. (*Elegant grasshopper*).—As last season, some damage locally to seedlings was recorded, and the pest was numerous in general in the Lower River. The chief oviposition sites occur along the river and stream banks, and this season the nymphs began to emerge in mid September.

Minor pests.—All the other minor pests mentioned in the 1956-57 Nyasaland Progress Report were less common this season, as were others not mentioned in those notes. *Hodotermes mossambicus* was as numerous but the hotter, drier weather early in the season did not encourage its activities, and little damage to seedling cotton was done.

Appendix.

Origin and Special Characteristics of the Main Cotton Strains Mentioned.

CLB	Crown Land Bulk, the commercial cotton variety of Nyasaland, mainly of U4 origin.
CL20	A selection from CLB, with longer and finer lint.
A637	An Albar 51 selection, which is being multiplied to replace CLB in Nyasaland.
A629, A640, A474	Albar 51 selections.
ABC30, etc.	Selections from a panmixis bulk containing Albar 49, BP52 and CL20.
AC31	Selection from a panmixis bulk containing Albar 49 and CL20.
Albar A(56)	Albar 51 selections made at Namulonge in 1956.
UPA(56)	Selections made at Namulonge in 1956 from hybrid material (MU8 × BP52[2]) × Albar 51.

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PROGRESS REPORTS FROM EXPERIMENT STATIONS

The reports for the seasons up to and including 1950-51 were published in seasonal volumes; the following are still in print and available at 3/- per volume post free.

1923-25 (one volume), 1926-1927, 1931-32, 1934-35,
1935-36, 1942-43 and 1945-46 to 1950-51.

From 1951-52 the reports from each territory were published individually each season. A few of the 1951-52 reports are out of print, but all others are available post free at 1/- per report or 7/6d. for the seasonal set.